First record of water mite from Tibet with an updated key to the genus *Sperchon* (Acari: Hydrachnidia: Sperchontidae) from China

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Abstract: Tibet is a biodiversity-rich area in China. But until now, no water mites have been recorded from Tibet. In this study, two water mite species, *Sperchon glandulosus* Koenike, 1886 and *Sperchon plumifer* Thor, 1902 are reported for the first time from Tibet, and *Sperchon glandulosus* is newly recorded from China. Descriptions and illustrations of *Sperchon glandulosus* are given herein. DNA barcodings for the two species are also referenced. A key to the 22 species (females) in the genus *Sperchon* from China is presented.

Key words: DNA barcoding; *Sperchon plumifer*; *Sperchon glandulosus*; taxonomy

西藏水螨新纪录及中国刺触螨属检索表（蜱螨亚纲：水螨群：刺触螨科）

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摘要：西藏为我国物种多样性非常丰富的地区，但是迄今该地区未有水螨的记录。本文报道采集自西藏的 2 种水螨：羽足刺触螨 *Sperchon glandulosus* Koenike, 1886 和伪腺刺触螨 *Sperchon plumifer* Thor, 1902，其中伪腺刺触螨为中国新纪录。文中对伪腺刺触螨进行了详细描述，绘制了该种的形态特征图，并提供了本文所采集标本的 DNA 条形码以及目前中国刺触螨属 22 种的检索表。

关键词：DNA 条形码；羽足刺触螨；伪腺刺触螨；分类

Introduction

Acari (mites and ticks) is a diverse group in the Arachnida. Most Acari inhabit terrestrial environments, but some have also adapted to living in aquatic ecosystems. Among the mites best adapted to living in the freshwater environment are the water mites (Hydrachnidia). Water mites have colonized all types of freshwater habitats including streams, rivers, ponds, lakes, springs and even the splash zone of waterfalls (Sabatino *et al*. 2008). Water mites are one of the most diversified and characteristic components of the aquatic invertebrate fauna (Sabatino *et al*. 2000). In many investigations of freshwater ecosystems, water mites have been used as bioindicators of clean water sources (Goldschmidt 2016).

Water mites are also a species-rich group; over 6,000 species of water mites have been recorded worldwide and the total species is estimated to reach upwards of 10,000 (Sabatino *et al*. 2008). However, the water mite is still a poorly studied group in China. Only 193 species

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of water mites have been described from China (Jin *et al*. 2010).

Tibet (also known as Xizang in Chinese) is located on the Tibetan Plateau which is abundant with freshwater. It is known as the "Asian water tower" and it is the headwater region for many of the important Asian rivers. Tibet also has a rich diversity of species, representing one of the biodiversity conservation hotspots of the world. Considering this resource of freshwater and the diversity of species, Tibet is a perfect region for water mites. Unfortunately, no water mites have been recorded from Tibet.

The water mite genus *Sperchon* Kramer, 1877 is the most species-rich among all genera in the family Sperchontidae Thor, 1900. It is widely distributed in the Holarctic, Oriental and Ethiopian regions (Cook 1974). Up to the present, 22 species have been recorded from China: *Sperchon beijingensis* Zhang & Jin, 2010; *S. brevipalpis* Jin, 1997; *S. curvipalpis* Zhang & Jin, 2010; *S. fluviatilis* Uchida, 1934; *S. fuxiensis* Zhang, 2017; *S. garhwalensis* Kumar, Kumar & Pesic, 2007; *S. gracilipalpis* Lundblad, 1941; *S. heteropoda* Zhang & Jin, 2010; *S. huangshanensis* Zhang & Jin, 2010; *S. lanigerus* Guo & Jin, 2011; *S. nikkoensis* Imamura, 1976; *S. oligospinis* Jin, 1997; *S. orbipatella* Zhang & Jin, 2011; *S. perspicuus* Zhang & Jin, 2011; *S. placoderma* Lundblad, 1941; *S. plumifer* Thor, 1902; *S. rostratus* Lundblad, 1969; *S. sounkyo* Imamura, 1954; *S. synsetus* Zhang & Jin, 2012; *S. turfanensis* Zhang & Jin, 2010; *S. urumqiensis* Zhang & Jin, 2011; *S. xiaoqikongensis* Zhang & Jin, 2012 (Jin 1997; Zhang *et al*. 2007; Jin *et al*. 2010; Zhang & Jin 2010; Zhang *et al.* 2010; Zhang & Jin 2011; Zhang *et al.* 2011; Zhang *et al*. 2012; Ding *et al*. 2017).

During our recent collecting in Tibet, two water mite species of the genus *Sperchon* were found: *S. plumifer* and *Sperchon glandulosus* Koenike, 1886. *S. glandulosus* is a new record for China. Descriptions and illustrations of *S. glandulosus* are given herein. DNA barcodings for the specimens examined in this study are also provided. A key to 22 species (females) of the genus *Sperchon* from China is updated.

Material and methods

Water mites were collected by hand netting and preserved in absolute ethanol in 1.5 ml centrifuge tubes. The centrifuge tubes were transported to the laboratory and stored at -20℃.

DNA extraction, PCR and sequencing for DNA barcoding followed Ding *et al*. (2017). All sequences were submitted to BOLD and GenBank. BOLD process ID and GenBank accession numbers are provided in Table 1.

Table 1. Information on the specimens in this study

species	sex	BOLD process ID	GenBank accession numbers
Sperchon glandulosus	Male	TISP001-18	MG895846
Sperchon glandulosus	Female	TISP002-18	MG895845
Sperchon glandulosus	Female	TISP003-18	MG895844
Sperchon plumifer	Female	TISP004-18	MG895848
Sperchon plumifer	Female	TISP005-18	MG895847

For morphological examination, the mites were dissected as described by Cook (1974). Terms follow Jin (1997) and modified. The following abbreviations are used:

A1, A2 — antennal glandularia 1 and 2; ACG — anterior coxal group (CxI + CxII); CxI–CxIV — coxae I–IV; D1–D4 — dorsoglandularia 1–4; E1–E4 — epimeroglandularia 1–4; L1–L4 — lateroglandularia l–4; O1, O2 — ocularia l and 2; PCG — posterior coxal group (CxIII + CxIV); P-I–P-V — palpal segments 1–5; V1–V4 — venteroglandularia 1–4; I-L-1–I-L-6 — the first leg segments 1–6; II-L-1–II-L-6 — the second leg segments 1–6; III-L-1–III-L-6 — the third leg segments 1–6; IV-L-1–IV-L-6 — the fourth leg segments 1–6. All measurements are given in *μm*.

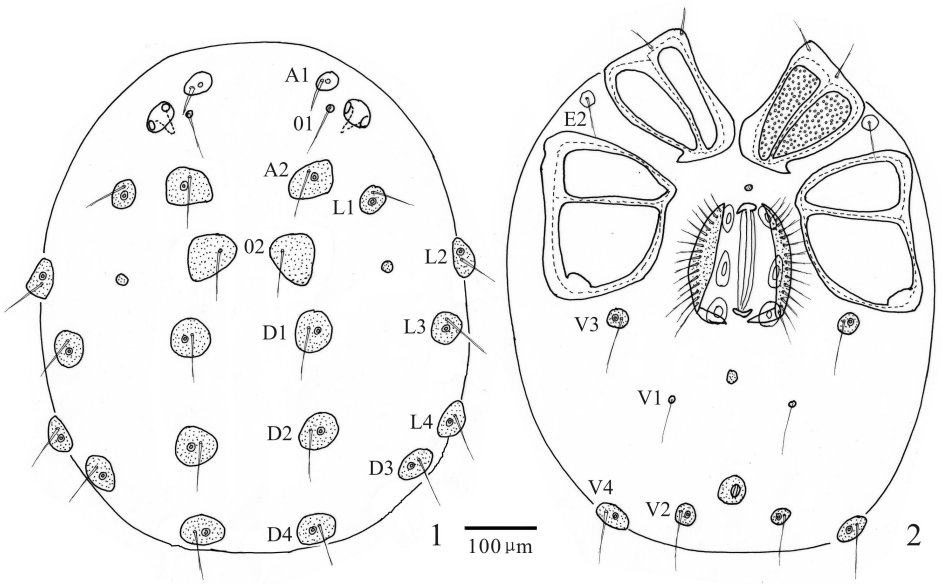
Systematics

Family Sperchontidae Thor, 1900

Genus *Sperchon* Kramer, 1877

1. ***Sperchon glandulosus*** **Koenike, 1886** (Figs. 1–10), new record to China

Specimens examined. 1♂2♀, Tibet Autonomous Region, Linzhi City, an unnamed stream. 29°34′39″N; 94°24′55″E, 14-VIII-2017, coll. Xu ZHANG.

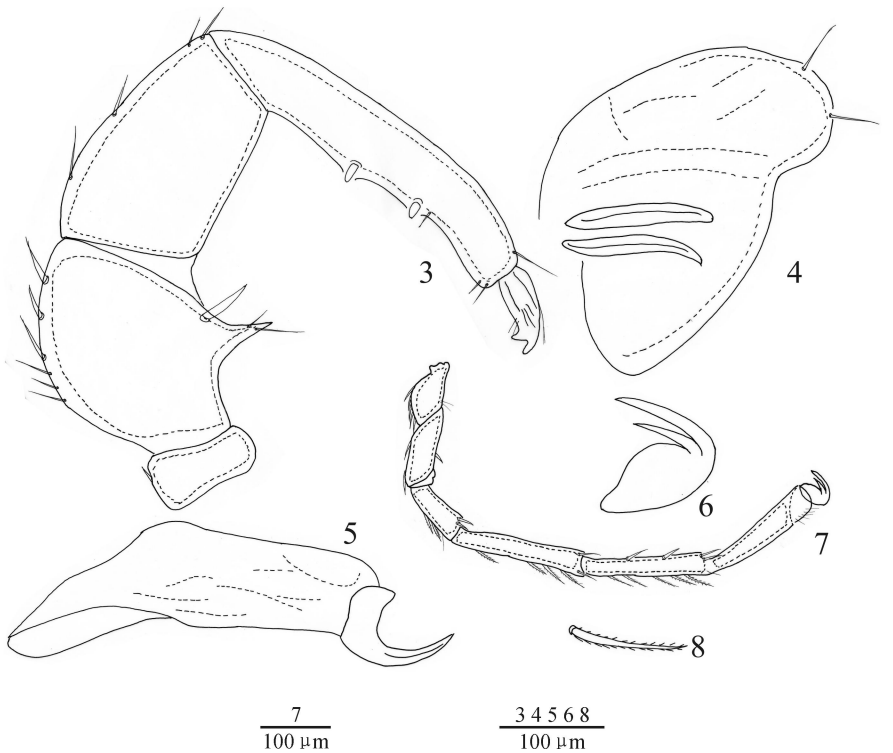


Figures 1, 2. *Sperchon glandulsous* Koenike, 1886, ♂. 1. Idiosoma, dorsal view; 2. Idiosoma, ventral view.

Description. Male (*n* = 1). Idiosoma oval in outline, 731 in length, 651 in width. A1 smooth, short and thick, other glandularia thin and long. Integument without dorsalia or ventralia except the platelets surrounding glandularia and O2. Coxae in four groups, surface of coxae punctate. ACG 163 in length, close to each other but not fused, posterior apodemes weakly developed. E2 on the lateral interval between ACG and PCG. PCG 237 in length. E4 close to anterior margin of CxIII. Distance between anterior end of ACG and posterior end of PCG 401. Genital field between PCG, 185 in length, 147 in width. A small and rounded platelet in front of genital field. Pre- and post-genital sclerites undeveloped. Three pairs of genital acetabula, the anterior two elliptic and the posterior one more or less rounded. V1

without accompanying glandularia but on small sclerites. Excretory pore anterior to the line of V2, and surrounded by a sclerotized ring.

Infracapitulum with a short rostrum, 167 in length. Chelicera total length 215, basal segment length 160, claw length 55, basal segment/claw length ratio 2.9. Dorsal lengths of the palpal segments: P-I, 29; P-II, 94; P-III, 111; P-IV, 173; P-V, 38. P-I short and with one dorsal seta. P-II with a long ventrodistal projection bearing two thin setae, of which one is longer than the other. One thick seta at the base of the projection, and almost the same length as the projection. About six setae on the dorsal and lateral sides of the P-II, of which none plumose. P-III with an empty ventral side but with four dorsal setae. P-IV venter with two peg-like setae, which dividing the venter of P-IV into three unequal parts. Dorsal lengths of leg I: I-L-1, 41; I-L-2, 73; I-L-3, 85; I-L-4, 153; I-L-5, 156; I-L-6, 158. Dorsal lengths of the fourth leg: IV-L-1, 87; IV-L-2, 118; IV-L-3, 122; IV-L-4, 252; IV-L-5, 238; IV-L-6, 230. The third to fifth segments of leg I-IV with rather short plumose setae in longitudinal rows (Fig. 8). Ambulacrum with two claws. Each claw with well-protruding claw blade and two clawlets (Fig. 6).



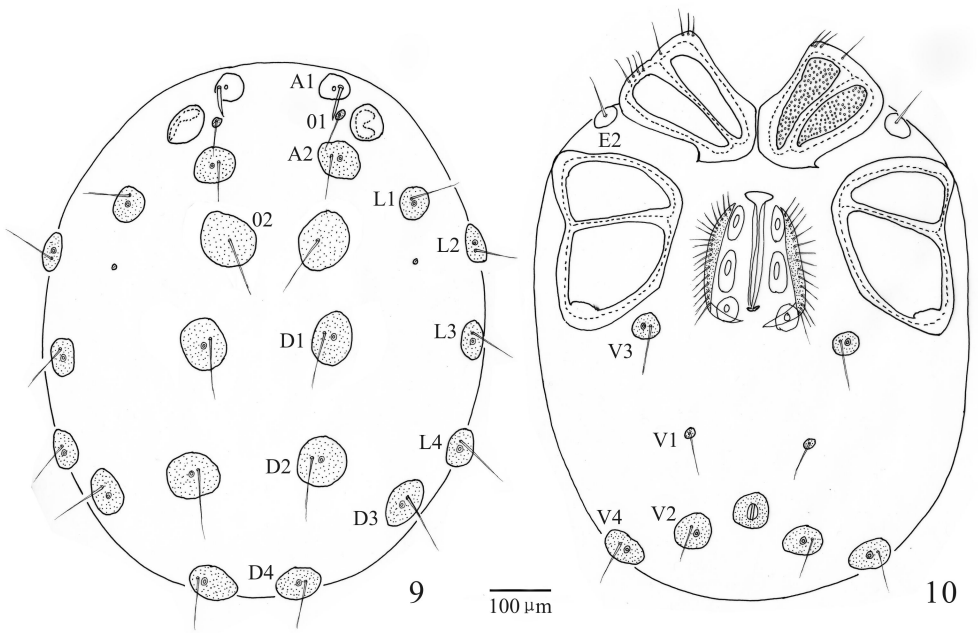
Figures 3–8. *Sperchon glandulosus* Koenike, 1886, ♂. 3. Palp; 4. Infracapitulum; 5. Chelicerae; 6. Claw; 7. IV-L-1-6; 8. Dorsal seta of IV-L-5.

Female (n = 2). Similar to male except for the morphology of genital field and the size of idiosoma. Idiosoma 890 (913) in length, 728 (786) in width. ACG 198 (210) in length, PCG 297 (227) in length. Distance between anterior end of ACG and posterior end of PCG 462 (497). Genital field 223 (240) in length, 151 (168) in width. Pregenital sclerite more developed

than the postgenital sclerite (Fig. 10). Infracapitulum length 205 (220). Chelicera total length 259 (286), basal segment length 69 (74), claw length 190 (212), basal segment/claw length ratio 2.8 (2.9). Dorsal lengths of the palpal segments: P-I, 23 (28); P-II, 108 (115); P-III, 183 (200); P-IV, 220 (245); P-V, 39 (43). Dorsal lengths of leg I: I-L-1, 53 (61); I-L-2, 89 (99); I-L-3, 121 (134); I-L-4, 191 (214); I-L-5, 216 (235); I-L-6, 181 (201). Dorsal lengths of leg IV: IV-L-1, 102 (115); IV-L-2, 136 (150); IV-L-3, 163 (187); IV-L-4, 312 (246); IV-L-5, 328 (342); IV-L-6, 274 (294).

Remarks. Due to the arrangement of the glandularia, E4 on the CxIII, P-II with a long ventrodistal projection and one thick seta, the two peg-like setae dividing the venter of P-IV into three unequal parts. This species shows a general conformity with *S. glandulosus*, a species which is widely distributed in the Palaearctic. The differences found in the body size, the number of the setae on the palp and the coxa between the Chinese and European specimens should be regarded as the variation between the geographically distant populations. Although *S. glandulosus* has been recorded in many papers (Uchida 1934; Marshall 1943; Bader 1974), the descriptions were short and insufficient. Many details were ignored in the descriptions and left out of illustrations (such as the shape of the claw and the plumose setae in longitudinal rows on the third to fifth segments of leg I-IV). *S. glandulosus* was described and illustrated in more detail (see the description and Figs. 1–10) in this study. In addition, we provide access to the DNA barcodings for *S. glandulosus*.

Distribution. China (Tibet); America; Germany; Japan; Italy; Turkey.



Figures 9, 10. *Sperchon glandulosus* Koenike, 1886, ♀. 9. Idiosoma, dorsal view; 10. Idiosoma, ventral view.

2. ***Sperchon plumifer*** **Thor, 1902**, new record to China

Specimens examined. 2♀, Tibet Autonomous Region, Linzhi City, an unnamed stream. 29°34′39″N; 94°24′55″E, 14-VIII-2017, coll. Xu ZHANG.

Description. Female (n = 2). Colour brownish. Integument with very fine spinules arranged in hexagonal pattern. Excretory pore with a sclerotized ring. P-II with a long ventrodistal projection. Idiosoma 975 (939) in length, 938 (901) in width. ACG 338 (297) in length, PCG 390 (347) in length. Distance between anterior end of ACG and posterior end of PCG 697 (625). Genital field 323 (304) in length, 262 (247) in width. Infracapitulum 366 (342) in length. Chelicera total length 405 (375), basal segment length 304 (282), claw length 101 (93), basal segment/claw length ratio 3.0. Dorsal lengths of the palpal segments: P-I, 57 (51); P-II, 225 (201); P-III, 282 (247); P-IV, 375 (318); P-V, 75 (61). Dorsal lengths of leg I: I-L-1, 127 (102); I-L-2, 135 (112); I-L-3, 173 (147); I-L-4, 278 (218); I-L-5, 300 (257); I-L-6, 285 (224). Dorsal lengths of the fourth leg: IV-L-1, 188 (165); IV-L-2, 210 (187); IV-L-3, 225 (201); IV-L-4, 375 (324); IV-L-5, 360 (298); IV-L-6, 352 (300).

Distribution. China; Japan; France; Korea.

Key to species (females) of the genus *Sperchon* in China

1. Palpal segments short and stocky, two peg-like setae on P-IV very thick and close together····· *S. nikkoensis*
-. Palpal segments short and slender, two peg-like setae on P-IV small and separated····· 2
2. P-III with ventral setae····· 3
-. P-III without ventral setae····· 4
3. The dorsal side of P-III incurved, P-III with one ventral heavy seta····· *S. curvipalpis*
-. The dorsal side of P-III straight, P-III with two ventral heavy setae····· *S. turfanensis*
4. Integument with various patterns, but not hexagon····· 5
-. Integument with very fine spinules arranged in hexagonal pattern····· 13
5. Ambulacrum with two claws, each claw bearing three clawlets····· *S. perspicuous*
-. Ambulacrum with two claws, each claw bearing two clawlets····· 6
6. Glandularia with rather large pore openings; P-II with a short and obtuse ventrodistal projection····· ····· *S. xiaoqikongensis*
-. The pore of glandularia not large; P-II with a long and pointed ventrodistal projection····· 7
7. Two peg-like setae fused at the base of the ventral side of P-IV····· *S. synsetus*
-. Two peg-like setae separated from each other at the ventral side of P-IV····· 8
8. The second acetabulum near to the third but far away from the first····· *S. orbipatella*
-. Three pairs of acetabula almost arranged equidistantly····· 9
9. Integument covered with fine threadlike decorations····· *S. lanigerus*
-. Integument lacking any various patterns····· 10
10. Integument covered with scale-shaped papillae····· 11
-. Integument covered with irregular ridges····· 12
11. One thin seta on the ventrodistal margin of P-II; excretory pore with a sclerotized ring····· *S. sounkyo*
-. One heavy seta on the ventrodistal margin of P-II; excretory pore without a sclerotized ring····· ····· *S. urumqiensis*
12. Excretory pore without sclerotized ring····· *S. fluviatilis*
-. Excretory pore with a sclerotized ring····· *S. glandulosus*
13. O1 in front of A1 and lateral eyes····· *S. huangshanensis*
-. O1 posterior to A1 and slightly anterior to the lateral eyes····· 14
14. P-II with a thin seta instead of ventrodistal projection····· *S. rostratus*
-. P-II with a long ventrodistal projection····· 15
15. The second acetabulum near to the third but far away from the first····· *S. beijingensis*
-. Three pairs of acetabula almost arranged equidistantly····· 16

16. P-IV shorter than P-III, or almost the same as P-III····· 17
-. P-IV longer than P-III·····18
17. E4 close to anterior margin of CxIII·····*S. garhwalensis*
-. E4 close to anterior margin of CxIV·····*S. brevipalpis*
18. Chitinous plates on both dorsum and venter well-developed, almost covering all the idiosoma·····
····· *S. placoderma*
-. Chitinous plates on both dorsum small, not covering all the idiosoma····· 19
19. E4 absent from CxIII····· *S. fuxiensis*
-. E4 on CxIII·····20
20. Three pairs of chitinous plates on dorsum·····*S. oligospinis*
-. Seven to nine pairs of chitinous plates on dorsum····· 21
21. Excretory pore with a sclerotized ring·····*S. plumifer*
-. Excretory pore without sclerotized ring·····*S. gracilipalpis*

Note: *Sperchon heteropoda* Zhang & Jin, 2010 was first recorded from Guizhou Province based on a single male. Because of a lack of a description of the female, *S. heteropoda* is not listed in the key above. Only 22 species of the genus *Sperchon* are included in the key.

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